and with a success which cannot be considered unsatisfactory. In temperate latitudes the above details will furnish a guide, and also the comparative table of the equatorial and temperate zones. The latter will not be found to deviate much in the warmer temperate climates, but is decidedly too great for higher parallels. Among the colder of these climates a mean of from 200 to 250 feet may be used for a depression of 1° of the thermometer.

[To be continued.]

XXIII.—*Observations on the Progress recently made in the Natural History of the* Echinodermata. By Prof. Agassiz*.

With a view of rendering more complete the results which, in the preface to the first of these Monographs, I have given of my investigation of the *Echinodermata*, I shall here offer some remarks upon the progress recently made in the natural history of this class.

The memoirs which have appeared during several years past, or which are at the present moment in course of publication respecting these animals, are sufficiently numerous. Of these some relate to their classification in general, or to the descriptive natural history of the genera and species; others have reference to their anatomy, both actual and comparative, or it may be that they embrace the study of the numerous fossils which have represented this class at the epochs of the development of organic life. It is in this order that we shall now pass them in review, and in conclusion I shall give some account of the collections which I have lately had the opportunity of examining.

As these different departments of inquiry in the natural history of the *Echinodermata* have advanced rapidly, it is the more to be regretted that a knowledge of their habits, of their alimentation, of their growth, of the functions of their organs, &c., should as it were rest stationary, if we except some detached observations upon the European species.

The only work [among the publications coming under consideration] which embraces the entire class *Echinodermata*, is the delightful volume which Mr. Edward Forbes has published upon the British species (History of British Starfishes and other animals of the class *Echinodermata*, 1840–41). He divides them into six orders:—1st, the *Pinnigrada* or *Crinoideæ*; 2nd, the *Spinigrada* or *Ophiuridæ*, which he subdivides

* From the 'Monographies d'Echinodermes,' No. 2. [We have been favoured by Mr. Charlesworth with the communication and translation of the present article.—Ed.]

into the *Ophiuræ* proper, and *Euryales*; 3rd, the *Cirrhigrada* or *Asteriadæ*, which he subdivides into the *Urasteriæ*, *Solasteriæ*, *Goniasteriæ*, and *Asteriæ* proper; 4th, the *Cirrhi-Spinigrada* or *Echinidæ*, for which he adopts the subdivisions proposed in my 'Prodromus;' 5th, the *Cirrhi-Vermigrada* or *Holothuriadæ*, of which he makes four families, the *Psolidæ*, the *Pentactæ*, the *Thyones*, and the *Synaptæ*; 6th, the *Vermigrada* or *Sipunculidæ*, which he subdivides into three families, the *Sipunculaceæ*, the *Priapulaceæ* and *Thalassamaceæ*. He also places in orders of equal rank, the *Crinoideæ*, the *Ophiuridæ* and the *Asteriadæ*, which in my 'Prodrome d'une histoire naturelle des Echinodermes' I had left in a single order; and he reunites to the *Echinodermata* the *Sipunculidæ*, which I had withdrawn to place them with the *Annelides*. I am indeed convinced, after seeing the preparations shown me by Mr. Forbes and Mr. Goodsir, that the *Sipunculidæ* are undoubtedly *Echinodermata*. The descriptions given by Mr. Forbes of the British species are far more complete than the descriptions previously in my possession; he has also considerably augmented their number, especially in the *Holothuriadæ* and *Sipunculidæ*. Conjointly with his friend Mr. Goodsir, Mr. Forbes has established the two new genera *Psolinus* and *Ocnus*, and has circumscribed in a most rigorous manner my genera *Uraster* and *Cribella* in the *Asteriadæ*. Many of the species described by Mr. Forbes were discovered by Mr. Thompson of Belfast, and Mr. Ball of Dublin. Mr. Forbes had previously published, in the eighth vol. of the 'Wernerian Transactions of Edinburgh,' a memoir upon the *Asteriadæ* of the Irish Sea, in which he had established two new genera (*Solaster* and *Luidia*) and described many new species.

MM. J. Müller and Troschel have undertaken a revision of the Starfishes (*Asteriadæ*), which they first divide into fourteen and then into sixteen genera, the characters of which are for the most part new and generally circumscribed within just limits. These genera are as follows:—*Asteracanthion*, Mül. and Tros. (Stellonia, Nard., Forb., Uraster, Ag.); *Pisaster*, Mül. and Tros.; *Stichaster*, Mül. and Tros.; *Echinaster*, Mül. and Tros.; *Crossaster*, Mül. and Tros. (Solaster, Forbes); *Chætaster*, Mül. and Tros.; *Ophidiaster*, Ag.; *Linckia*, Nard. (Mül. and Tros.); *Goniaster*, Ag.; *Platyaster*, De Blain. (Scutasterias, De Bl.); *Asterope*, Mül. and Tros.; *Culcita*, Ag.; *Asteriscus*, Mül. and Tros. (Asterina, Nard., Palmipes, Linck); *Archaster*, Mül. and Tros.; *Asterias*, Ag. (Astropecten, Linck, Stellaria, Nard.); *Hemicnemis*, Mül. and Tros. (Luidia, Forbes). The researches of these gentlemen, as yet only made known by extracts which have appeared in the Bulletins of the Aca-

demy of Berlin for April 1840, and in Wiegmann's 'Archives' for the same year (pp. 318 and 367), contain valuable details upon the organization of these animals. More recently MM. Müller and Troschel have extended their investigation to the *Ophiuridæ*, and have published a highly interesting sketch of the genera in this family, whose number they contend is not less than eight, without including the genera which I have established in the fossil species. These genera are *Ophiolepis*, Mül. and Tros.; *Ophiopholis*, Mül. and Tros.; *Ophiocoma*, Ag.; *Ophiothrix*, Mül. and Tros.; *Ophioderma*, Mül. and Tros. (Ophiura, Lam.); *Ophionyx*, Mül. and Tros.; *Ophiomyxa*, Mül. and Tros.; and *Ophiocnemis*, Mül. and Tros. (Wieg. Archiv, 1840, pp. 326–368).

Mr. J. E. Gray has published an extended and very important memoir on the *Asteriæ* in the 'Annals and Magazine of Natural History' for Nov. and Dec. 1840. The tendency of this memoir differs altogether from that published by MM. Müller and Troschel; for whilst the Berlin naturalists had especially in view the study of the organization of the *Asteriæ* in detail, Mr. Gray had for his object the grouping in the most natural manner the entire assemblage of species which he had had occasion to examine, and which are very numerous, particularly in the section of the *Pentacerotidæ*. Mr. Gray establishes among the true *Asteriæ* alone, forty-five genera (besides numerous subgenera), which he divides into the four following families:—

Asteriadæ, Gray: *Asterias*, Gray (Pentasterias, De Bl., Stellonia, Nardo, Forbes, Uraster, Ag., Asteracanthion, Mül. and Tros.); *Heliaster*, Gray (Solasterias, De Bl.); *Tonia*, Gray (Stichaster, Mül. and Tros.).

Astropectinidæ, Gray: *Nauricia*, Gray (Archaster, Mül. and Tros.); *Astropecten*, Linck (Asterias, L., Ag., Crenaster, Linck, Stellaria, Nardo); with the subgenus *Astropus*, Gray, *Luidia*, Forbes (Hemicnemis, Mül. and Tros.); *Petalaster*, Gray; *Solaster*, Forbes (Crossaster, Mül. and Tros.); with the subgenera *Endeca*, Gray, and *Polyaster*, Gray; *Henricia*, Gray (Linckia, Forbes, Cribella, Ag., Forbes).

Pentacerotidæ, Gray. 1st, *Pentacerotina*: *Culcita*, Ag.; *Pentaceros*, Linck, Gray (Goniaster, Ag.), with the subgenera *Nidorellia*, Gray; *Stellaster*, Gray; *Comptonia*, Gray; *Gymnasteria*, Gray (Asterope, Mül. and Tros.); *Paulia*, Gray; *Randasia*, Gray; *Anthenea*, Gray; *Hosea*, Gray; *Hippasteria*, Gray; *Calliaster*, Gray; *Goniaster*, Ag. (Gray); *Pentagonaster*, Gray; *Tosia*, Gray. 2nd, *Echinasterina*: *Echinaster*, Gray (now Mül. and Tros.). 3rd, *Cribellina*: *Othilia*, Gray (Echinaster, Mül. and Tros.); *Metrodira*, Gray (Chætaster, Mül. and Tros.); *Rhopia*, Gray (Echinaster, Mül. and Tros.); *Ferdina*, Gray; *Dactylosaster*, Gray (Ophidaster, Agass.); *Tamaria*, Gray; *Cistina*, Gray; *Ophidiaster*, Ag., with the subgenera *Hacelia*

and *Pharia*, Gray; *Linckia*, Nardo, Gray, with the subgenera *Phataria*, Gray; *Fromia*, Gray (Linckia, Nardo); *Gomophia*, Gray; *Nardoa*, Gray (Linckia, Nardo); *Narcissia*, Gray; *Nectria*, Gray; *Nepanthia*, Gray; *Mithrodia*, Gray; *Uniophora*, Gray.

Asterinidæ, Gray: *Palmapes*, Linck (Anseropoda, Nardo, Palmasterias, De Blainv., Asteriscus, Mül. and Tros.); *Porania*, Gray (Goniaster, Forbes); *Asterina*, Nardo (Ctenaster, Ag., Asteriscus, Mül. and Tros., Pentaceros, Linck); *Partiria*, Gray; *Socomia*, Gray.

Notwithstanding their multiplicity, the greater part of these divisions appear to me natural, and I think that they should be adopted after a correction of the nomenclature, for many of the generic terms are synonymous with those of MM. Müller and Troschel and others, as may be seen from the names which I have added in parenthesis to the names proposed by Mr. Gray. It is much to be regretted that this gentleman should not have been cognisant of the memoir by MM. Müller and Troschel, which has nevertheless six months' priority over his. Mr. Gray regards the *Asteriæ* as a distinct class, to which he gives the name Hypostoma; but I think that their separation from the other *Echinodermata* should be justified upon anatomical as well as zoological evidence. In fact, the character by which hitherto it has been principally asserted that the Starfishes may be distinguished from the Sea-urchins is fallacious, since most of the *Asteriæ* possess an *anus*, as was first pointed out by M. J. Müller.

M. Ch. Desmoulin's researches among the *Echinites* is a work which should be in the hands of all those who pursue the natural history of the *Echinodermata*. Without entering here upon any detailed statement, I shall simply mention that M. Desmoulins does not admit more than seventeen genera in the order of the *Echinidæ*, which are *Clypeaster*, *Scutella*, *Fibularia*, *Cassidulus*, *Galerites*, *Pyrina*, *Echinometra*, *Echinus*, *Echinocidaris*, *Diadema*, *Cidaris*, *Echinoneus*, *Echinolampas*, *Nucleolites*, *Collyrites*, *Ananchytes* and *Spatangus*. Previously to this publication M. Desmoulins had published a descriptive catalogue, with two plates, of the living and fossil *Stelleridæ* of the Gironde (Actes de la Soc. Linnéenne de Bordeaux, tom. v.).

Among the works especially deserving notice is the monograph upon the *Asteriæ* allied to *Asterias aurantiaca*, which M. Philippi has published in Wiegm. 'Archiv,' 1837, vol. i. p. 193, and the description of a new and most curious living genus of *Crinoideæ*, named *Holopus*, which M. d'Orbigny has published in Guérin's 'Mag. de Zool.' for 1837*. In a

* Translated with illustrations in Mag. Nat. Hist., New Series, vol. iv. p. 352.—Ed.

monograph which it is my intention shortly to publish upon the living species of the genus *Echinus* (Auct. Antiq.) I have established the following divisions, of which I here only indicate the typical species: *Temnopleurus* (Ech. toreumaticus), *Pleurochinus* (E. bothyroides), *Microcyphus* (E. versicolor), *Tripneustes* (E. ventricosus), *Amblypneustes* (E. griseus), *Taxopneustes* (E. pileolus), *Stomopneustes* (E. variolaris). I have also thought it better to form three subdivisions of the genus *Arbacia*, restricting that name to the small fossil species, and proposing that of *Tragypus* for the species whose anus is closed by a valve of four pieces, and that of *Agarites* for those which have the interambulacral areas partially destitute of tubercles and spines.

The *Holothuriæ* are always the division of *Echinodermata* in which there remains the most to be effected. The difficulty of observing these animals has hitherto not enabled the science to be supplied with designs (*planches*) sufficient for its exigencies. There are none but those which are published by MM. Quoy and Gaimard in the 'Zoological Atlas of the Astrolabe,' and which, as it regards their execution, do not leave anything to be wished for; but as it respects their distribution into genera, a great deal too much of vagueness and uncertainty is presented by the characters selected as the basis of the groups.

Oken (Lehrbuch der Naturgeschichte, 1815) was the first to divide the *Holothuriæ* into four genera, which he calls *Thyone*, *Subuculus*, *Holothuria* and *Psolus*. Lamarck only admits two genera in this family, the *Holothuriæ* and the *Fistulariæ*; these genera again are not well determined. Cuvier, without giving generic names to his divisions, has nevertheless established, in the first edition of the 'Règne Animal,' six very natural sections in the genus *Holothuria*, the first of which corresponds to the genus *Psolus* of Oken, the second to the genus *Cuvieria* of Peron, the third and fourth to the true *Holothuriæ*, the fifth and sixth to the genus *Subuculus* of Oken, which is also synonymous with the genus *Cucumaria*, Auct., or *Pentacta* of Goldfuss; lastly, the sixth corresponds to the genus *Thyone* of Oken, which Mr. Fleming has named *Müller*ia in his 'History of British Animals,' but which is not the genus *Mülleria* of Jæger. Eschscholtz subsequently established in the 'Zoological Atlas,' after the second voyage of Capt. Kotzebue round the world, two new genera under the names *Synapta* and *Chisodota*, which correspond to the genus *Tiedemannia* of Leuckardt (Isis, 1831, Compte rendu de la réunion des Naturalistes Allemands à Hambourg). M. Leuckardt has also established the genera *Phascolosoma* and *Oche-*

tostoma in the family *Sipunculaceæ*; the first in his address upon the anniversary of Blumenbach (*jubilé de Blumenbach*), the second conjointly with M. Ruppell, in the Atlas appended to the journey into the north of Africa.

M. Jæger, in his dissertation upon the *Holothuriæ* (Zurich, 1833–4), has established three new divisions under the names *Mülleria, Bohadschia* and *Trepang*; but his genus *Mülleria* is not, as he supposes, identical with the genus *Mülleria* of Fleming. The second part of this treatise has reference to the anatomical details. In my Prodromus of a monograph upon the *Radiata* or *Echinodermata*, I restricted myself, as it regarded the order *Holothuriæ*, to enumerating that which had been already published, not having made at that time any observations of my own upon these animals.

The most extensive work which has appeared for a long time upon the *Holothuriæ* is that of Brandt; it forms part of his 'Prodromus descriptionis animalium ab H. Mertensio observat.' &c., inserted in the 'Recueil des Actes de la séance publique de l'Acad. des Sc. de St. Petersbourg,' 1835. He at first divides this family into two large groups, the *Pedatæ* and the *Apodes*; then he subdivides the Pedatæ into the *Homoipodes* and *Heteropodes*; the Homoipodes are in their turn divided into the *Dendropneumones* and *Apneumones*; the Dendropneumones again into *Peripodes* and *Hypopodes*, and the Peripodes into *Pentastichæ* or *Sporadipodes*; then the Pentastichæ are *Adeptopneumones* with the genera *Cladodactyla* (and the subgenera *Polyclados* and *Hologoclados*, Br.) and *Dactylota*, Br., or *Detopneumones*, with the genus *Aspidochir*, Br. The Sporadipodes only include the genus *Sporadipus*, Br., with the subgenera *Colpochirota* and *Acolpos*, Br. The Hypopodes, which are all *Platygastricæ*, include the genera *Psolus*, Oken (Jæg.), and *Cuvieria*, Per., and the Apneumones the single genus *Oncinolabes*, Br. The Heteropodes he subdivides into the *Stichopodes*, Br., with the genera *Stichopus* (which includes the subgenera *Perideris* and *Gymnochirota*, Br.) and *Diploperideris*, Br., and *Sporadipodes*, Br., which are either *Aspidochirotæ*, Br., with the genera *Holothuria*, Lin. (Br.) (and the subgenera *Thelenota, Camarosoma, Platysoma* and *Microthele*, Br.), *Bohadschia*, Jæger, *Mülleria*, Jæg., *Trepang*, Jæg., or *Dendrochirotæ*, with the genus *Cladolabes*, Br. The second great group, the Apodes, are subdivided into the *Pneumonophoræ*, with the genera *Liosoma*, Br., and *Chirodota*, Esch., and into *Apneumones*, with the genus *Synapta*, Esch. This systematic arrangement is accompanied by the description of a great number of species, principally discovered by Mertens.

Brandt afterwards describes three new species of *Sipuncu-*

lus and an *Echiurus*. Lastly, in the order of *Echinidæ* he establishes the following genera:—*Strongylocentrotus* for some new species, *Heterocentrotus* for the species of which I have formed the genus *Acrocladia*, *Colobrocentrotus* for those which I place in my genus *Podophora*, and *Phyllacanthus* for the *Ciderites* with large cylindrical and tuberculated spines.

M. De Blainville, in the 'Dictionary of Natural Sciences' (vol. lx.), only admits in the family *Holothuriæ* the five following genera:—*Cuvieria*, *Holothuria*, *Thyone*, *Fistularia* and *Cucumaria*; but in the Supplement to his 'Manuel d'Actinologie' he divides it into six groups, in which he adopts in part the genera proposed by his predecessors. His articles upon the *Echinodermata* in the 'Dictionary of Natural Sciences,' and in his 'Manuel d'Actinologie,' which is a systematic collection, contain much valuable information upon the entire class. Lastly, the numerous notes appended by M. Desjardin to the third volume of the second edition of Lamarck's 'Animaux sans Vertèbres,' have in this work brought up the history of the *Echinodermata* to the actual state of the science.

At my solicitation Professor Valentin has undertaken for the present publication, a general revision of the anatomy of the *Echinodermata*; his first monograph, embracing the anatomy of the genus *Echinus*, is already completed. Eight folio plates, drawn under the superintendence of M. Valentin by M. Dickmann, a very skilful draughtsman, are also lithographed, and the accompanying text is going through the press at this moment. The scientific world knows what it may look for from the dissecting-knife and the pen of M. Valentin; I shall only remark here, in justice to his disinterestedness, that M. Valentin, at his own expense, has made a voyage along the coasts of the Mediterranean for the special purpose of devoting himself to the necessary researches for completing this undertaking. Monographs upon the organization of these animals are at the present time so much the more necessary, as since the labours of Tiedemann and Delle Chiage, the greater part of the investigations made in this department of science relate to points of detail. The article '*Echinodermata*' by Sharpey, in Todd's 'Encyclopædia of Anatomy and Physiology,' contains a summary of all that is known of the organization of this class of animals.

Some monographs of very recent date have helped to extend this branch of scientific research. M. Grube has published a very complete anatomical description of the *Sipunculus nudus*, accompanied with well-executed illustrations (Müller's Archiv, 1837, p. 237). M. Krohn (ibid, 1839, p. 348)

has added some details upon the nervous system of this species which had escaped the observation of M. Grube.

M. J. Müller has studied in great detail the organization, considered comparatively, of the *Pentacrinus Caput Medusæ*, of which he has just procured an example, preserved in spirits of wine. The publication of his memoir will form a most important addition to our knowledge of the anatomy of the *Echinodermata*: unfortunately as yet an extract of it only has appeared in the Bulletin of the Berlin Academy for April 1840; but so concise, and so rich in new facts, that it would be necessary to quote it entire to give a just idea of its value. So much of it as is already made public is of the highest interest, whether considered anatomically or zoologically. M. J. Müller, in his description of the solid parts of this animal, rejecting the fanciful nomenclature first employed by Miller, and subsequently by all those who have since written upon the *Crinoideæ*, proposes a far more simple terminology for its complex frame-work.

Many points of detail relating to the anatomy of the *Echinodermata* have been investigated with equal success. M. Krohn has published a very interesting memoir upon the nervous system of the *Echinidæ* and *Holothuriadæ* (Müller's Archiv, 1841, p. 1), which M. van Beneden has observed in the Sea-urchins (Instit., No. 273, p. 96). Ehrenberg first discovered the existence of eyes in the *Asteriæ* (Müller's Archiv, 1834, p. 570), and described their connexion with the nerves of the rays; they may be very easily seen in many species, even when in the dry state. Mr. Forbes subsequently pointed them out in the Sea-urchins (Hist. Brit. Starf., p. 152), and I have since observed them in many species. MM. Ehrenberg (Müller's Archiv, 1834, p. 580), de Siebold (ibid, 1836, p. 291), Valentin (Repert., vol. ii. p. 26), and J. Müller (Bul. de l'Acad. de Berlin, 1840), have given detailed information respecting the calcareous network of which the solid framework (*charpente solide*) of the *Echinodermata* is composed. For my own part I have endeavoured to determine the laws of the disposition and of the increase of the separate plates, and their analogy in different families (Mémoires de la Soc. des Sc. Nat. de Neuchâtel, tom. i. p. 2—6 and 7—11), respecting which M. Philippi has offered certain objections (Wiegmann's Archiv, 1837, vol. i. p. 194). M. Duvernoy has communicated to the French Academy of Sciences his ideas respecting the solid framework of these animals (Instit. 1837, No. 216, p. 208), to which he attributes an internal skeleton, but *périphérique* (Sea-urchins), whilst he regards

the *Asteriæ* as formed of the union of numerous individuals attached around a common mouth. In a notice on some points of the organization of the *Euryales* (Mém. de la Soc. des Sc. Nat. de Neuchâtel, tom. ii.), I have given circumstantial details of the structure and disposition of the solid parts of these animals, and have described comparatively two new species.

Messrs. Sars and Forbes have reviewed what Otto Fr. Müller has said respecting the *Pedicellariæ* of the *Echinodermata*, and have added some new observations upon these singular bodies (Hist. of Brit. Starf., p. 155).

[To be continued.]

XXIV.—*On the Natural Arrangement of Fishes.* By W. S. MacLeay, Esq., A.M., F.L.S., in a Letter to J. M'Clelland, Esq., dated Elizabeth Bay, near Sidney, N. S. W., September 12th, 1840*.

My Dear Sir,

I cannot find terms to express my gratitude for your kind letter of the 12th March last, and for the very valuable present which it accompanied. I assure you, that your excellent work on *Cyprinidæ* has afforded me the greatest delight, and the more so, inasmuch as I am convinced natural arrangement is always best tested by accurate analysis, and also inasmuch as I am not by any means satisfied with Swainson's arrangement of Fishes. As from everything Swainson writes there is information to be derived, so I assure you, his little volume on Reptiles and Fishes has not been lost on me; yet the perusal of your Monograph on Indian *Cyprinidæ*† has made me recur to my old views on a subject which our common friend Dr. Cantor may have told you has long occupied my thought; and although perhaps you will deem these views not sufficiently worked out, and rather crude, I cannot refrain from making you acquainted with them, in order that I may have the benefit of comparing your general arrangement of Fishes with my own.

Fishes form a class of Vertebrata which has never yet been satisfactorily divided into orders. I do not think that *Acanthopterygii* and *Malacopterygii*, for instance, are natural orders. In order therefore to arrive at the first great and natural division of Fishes, I think we must commence by incontestable data, or at least by facts that are generally agreed on. Such facts, for instance, I hold to be the three following, viz. 1. The near approach of fishes to Batrachian Amphibia, which with Swainson I consider to be made by means of *Lophius* and *Malthe*. 2ndly. The near approach of fishes to Cetaceous Mammalia, which with him also I consider to take place by means of *Selache* and the viviparous Sharks. 3rdly. As the grand character of fishes as a class is, their being the most imperfect of Vertebrata,

* From the Calcutta Journal of Nat. Hist. for July 1841.

† See Ann. and Mag. Nat. Hist., vol. viii. p. 35.